Innovation in feed additives

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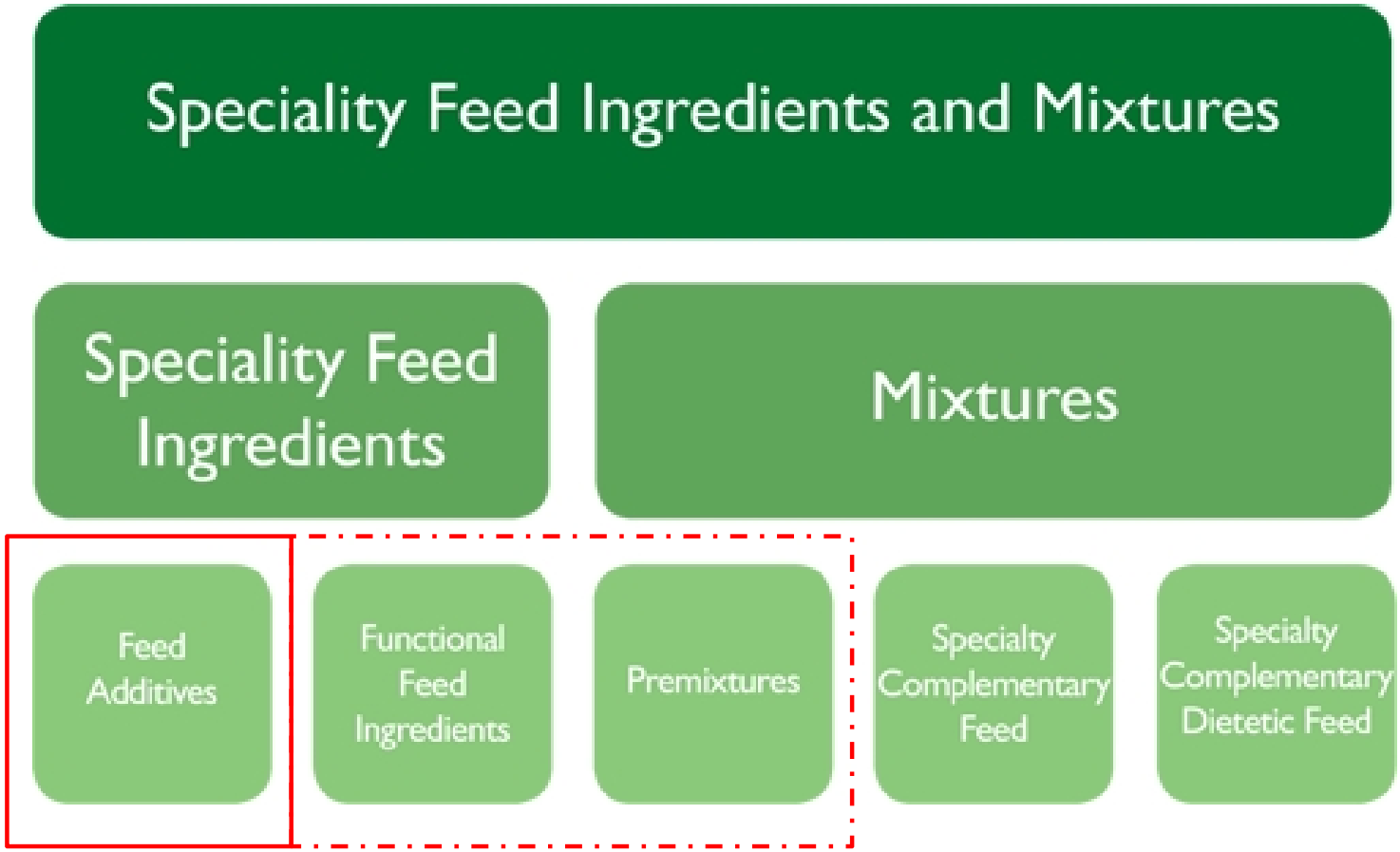
Engineering your feed solutions

Innovation in feed additives

- Introduction
- Feed additives by category
- Development of feed additives developments over time
- Case study 1: Emulsifiers
- Case study 2: Selenium
- Future fields of research

Categories of feed additives



Source: Fefana

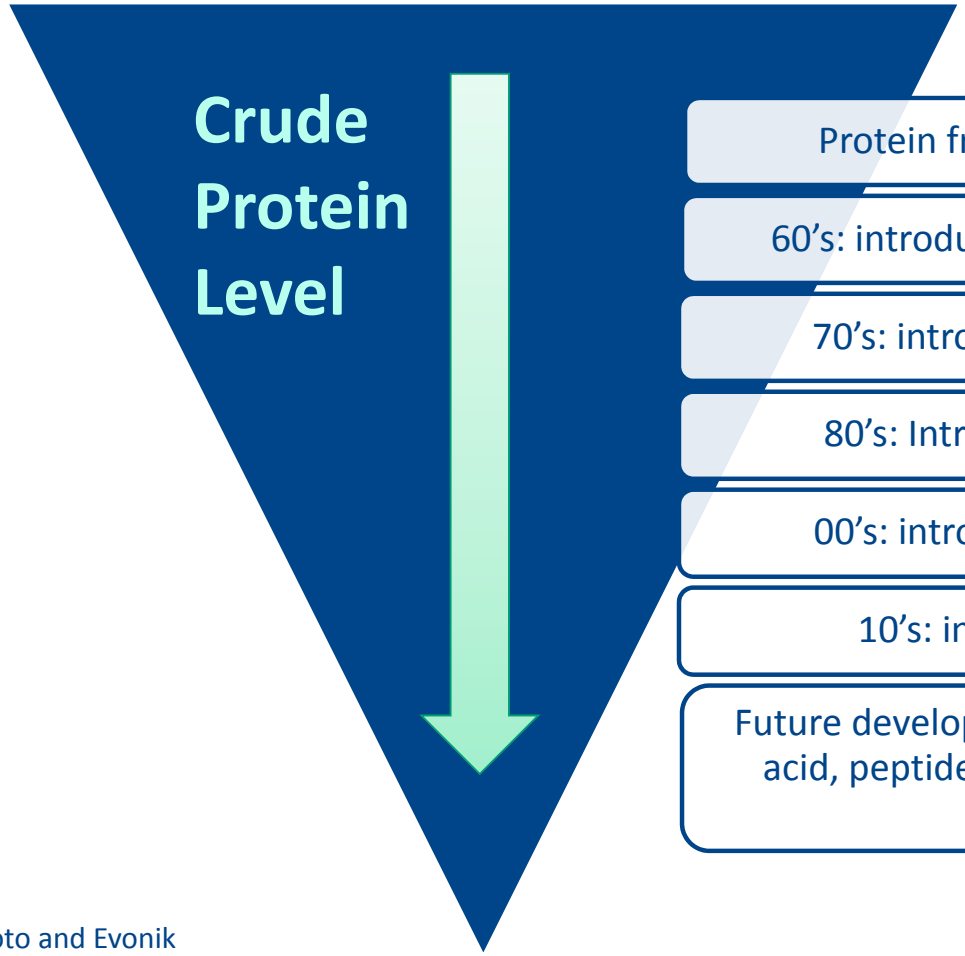
Categories of feed additives

Classification of basic feed additives

Nutritional feed additives	Non- nutritional feed additives
Amino Acids Minerals Vitamins Micronutrients	**Technological additives** (enzymes, emulsifiers, preservatives, antioxidants, stabilizers, acidity regulators,….) **Zootechnical additives** (digestibility enhancers, gut flora stabilizers,….) **Sensory additives** (flavours, colourants, …) **Coccidiostats and histomonats**

Source: European Commission; Regulation (EC) No 1831/2003

Developments over time (Amino Acids)



- Protein from raw materials only
- 60's: introduction of feedgrade Lysine
- 70's: introduction of Methionine
- 80's: Introduction of Threonine
- 00's: introduction of Tryptophan
- 10's: introduction of Valine
- Future developments; next limiting amino acid, peptides, functional applications, organic foods

Source:
adjusted from Ajinomoto and Evonik

Developments over time (Minerals)

Inorganic

A specific metal bound to a non-carbon-containing ligand.

Developed in the 1950's

ZnO; CuO; MnO; $CuSO_4$; $ZnSO_4$; $MnSO_4$; …

Organic

A specific metal bound to a carbon-containin ligand.

Developed in the 1970's

Zn-Aminoacid-Complex; Cu-Chelate; Glycinates; …

Hydroxy

A specific metal bound via a coordinated covalent bond with a hydroxyl ligand.

Developed in late 1990's

$Zn_5(OH)_8Cl_2 \cdot H_20$

Zinc chloride hydroxide monohydrate

$Cu_2(OH)_3Cl$

Dicopper chloride trihydroxide

Spectrum of Bond Strength

Too Weak
(e.g., sulfates, organic acid salts)

"Sweet Spot"
(e.g., hydroxy trace minerals)

Too Strong
(e.g., oxides, EDTA)

Source:
adjusted from MicroNutrients

Developments over time (Gut level)

FEED HYGIENE
(ORGANIC ACIDS)

PATHOGEN CONTROL
(PLANT EXTRACT / COATED OA / MCFA)

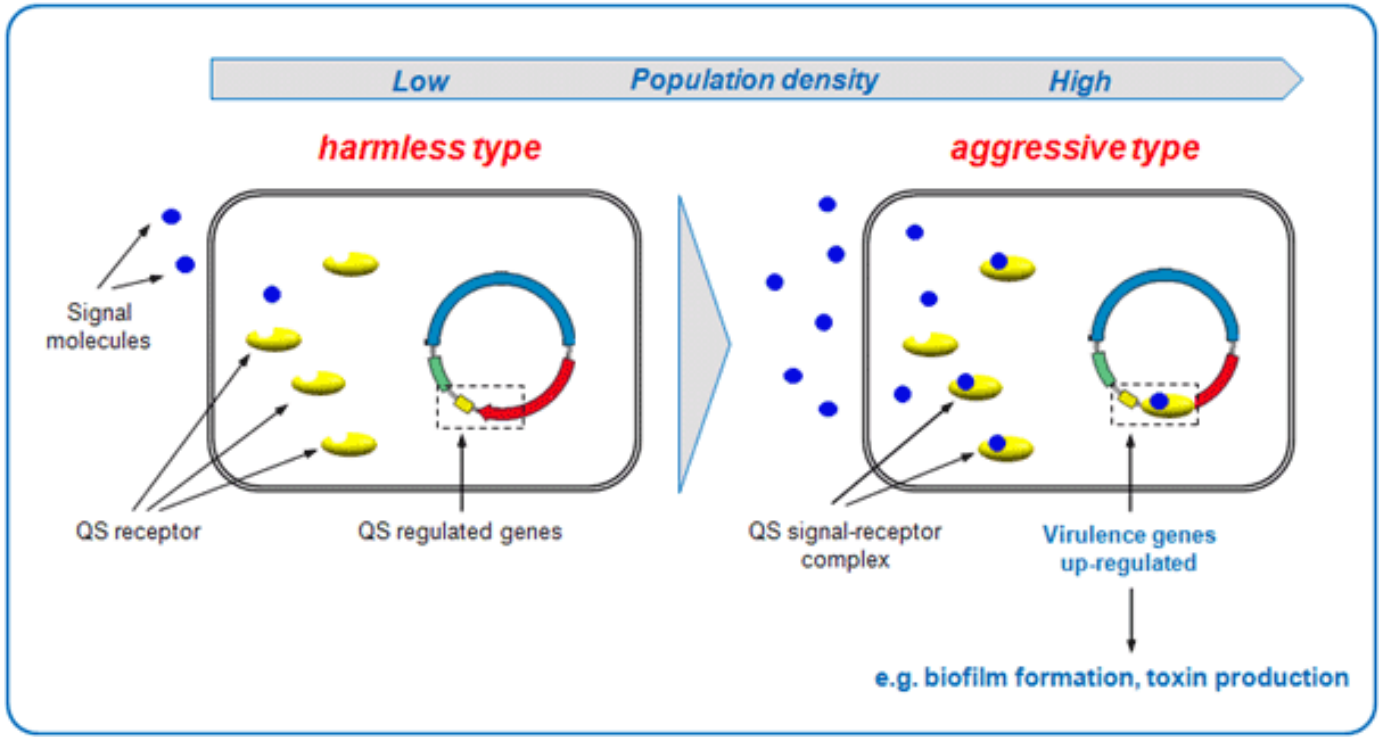
BALANCED MICROFLORA
(PRO- AND PREBIOTICS / BACTERIOPHAGES)

INTESTINAL HEALTH
(VILLI/CRYPTH TIGHT JUNCTIONS CELL METABOLISM)

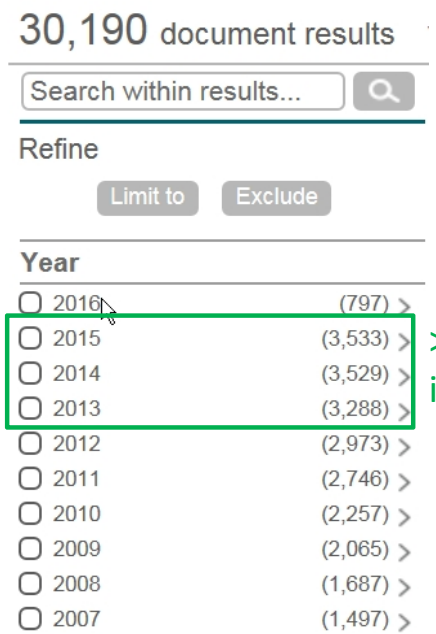
DIET-HOST INTERACTION
(IMMUNE MODULATION GENE EXPRESSION)

MICROFLORAL COMMUNICATION
(QUORUM SENSING)

Quorum sensing– innovation driven by new field of research



Peer-reviewed literature search (via scopus): "quorum sensing"



> 30% published in last 3 years

Quorum sensing– innovation driven by new field of research

New field of research opens doors for:

- New molecules
  - Quenching Enzymes — Cheng ea (2015)- Substitution of antibiotics in animal husbandry
  - Others?
- New applications for excisting molecules:
  - Probiotics — Novita ea (2015)- Probiotic Bacillus Sp. produces AHL Lactonase
  - Plant extracts — Yang ea (2015)- Tannin rich pommegranate inhibits QS in E.Coli
- Evaluation of existing molecules
  - Parameter to measure pathogenicity

Case study 1: Progress in emulsifiers

First reports on application of soy-derived lecithin in animal feed industry starts around 1985

(Sontag ea (1985)- Growth potential of soybean oil products for industrial materials)

In 5-10 years time development of (modified) lysolecithins started

(Jones ea (1992)- Effects of exogenous emulsifiers on digestion and performance in weaning piglets)

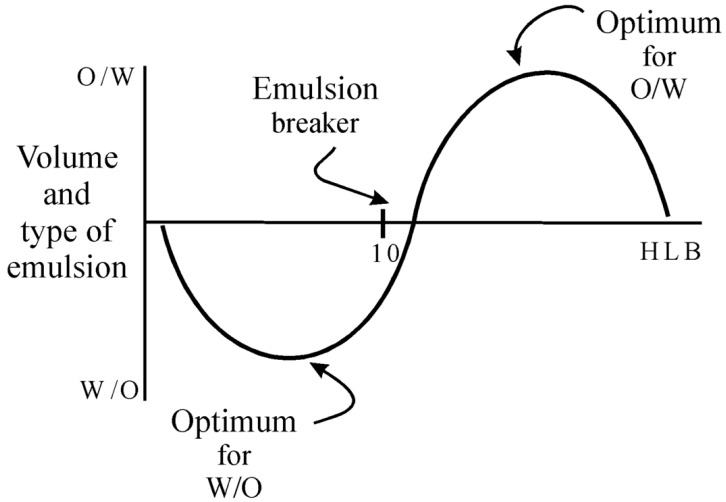
Awareness on importance of HLB values allows introduction of new molecules

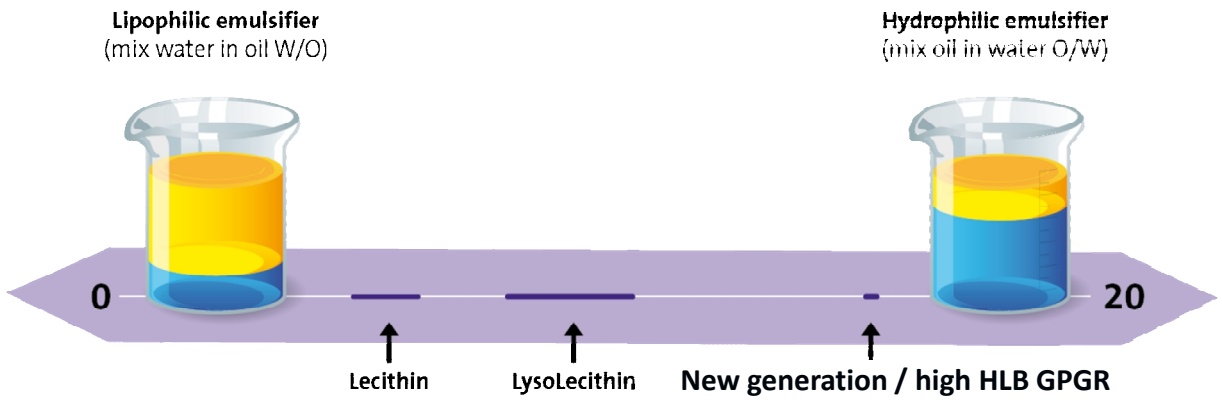
(Maertens ea (2013)- The effect of different emulsifiers on fat and energy digestibility in broilers)

Case study 1: Progress in emulsifiers

- Hydrophillic-Lipophillic Balance (HLB); Concept for choosing emulsifiers
- Based on old knowledge; Rule of Bancroft (1912):

  "The emulsifier should be soluble in the continuous phase"
- Range from 1-20





Emulsifiers – innovation driven by knowledge functional properties

Diet	HLB	Fat dig. (%)	CP dig. (%)	GE dig. (%)	ME kJ/kg DM	N ret. kJ/kg	MEn/kg DM kJ	MEn/kg DM kcal	Upgrade (kcal) vs control
Control		63.0 [a]	56.9 [a]	68.2 [a]	13 907 [a]	759 [a]	13 149 [a]	3143 [a]	-
Emulsifier A	13,2	68.4 [b]	60.1 [d]	71.1 [b]	14 493 [b]	802 [d]	13 691 [b]	3272 [b]	129
Emulsifier B	**16,7**	**70.5 [b]**	**59.7 [cd]**	**71.2 [b]**	**14 519 [b]**	**797 [cd]**	**13 723 [b]**	**3280 [b]**	**137**
Emulsifier C	13,5	68.5 [b]	58.1 [ab]	70.4 [b]	14 356 [b]	776 [ab]	13 589 [b]	3246 [b]	103
Emulsifier D	>15	67.5 [ab]	58.5 [bc]	71.2 [b]	14 509 [b]	781 [bc]	13 728 [b]	3281 [b]	138

Maertens et al (2013), The effect of different emulsifiers on fat and energy digestibility in broilers

Case study 2: Progress in Selenium nutrition

Originally selenium was derived from raw materials

Introduction of supplemented selenium via inorganic sources (selenite/selenate)

(FDA approval by 1974; Ammerman ea (1975)- Selenium in ruminant nutrition-a review)

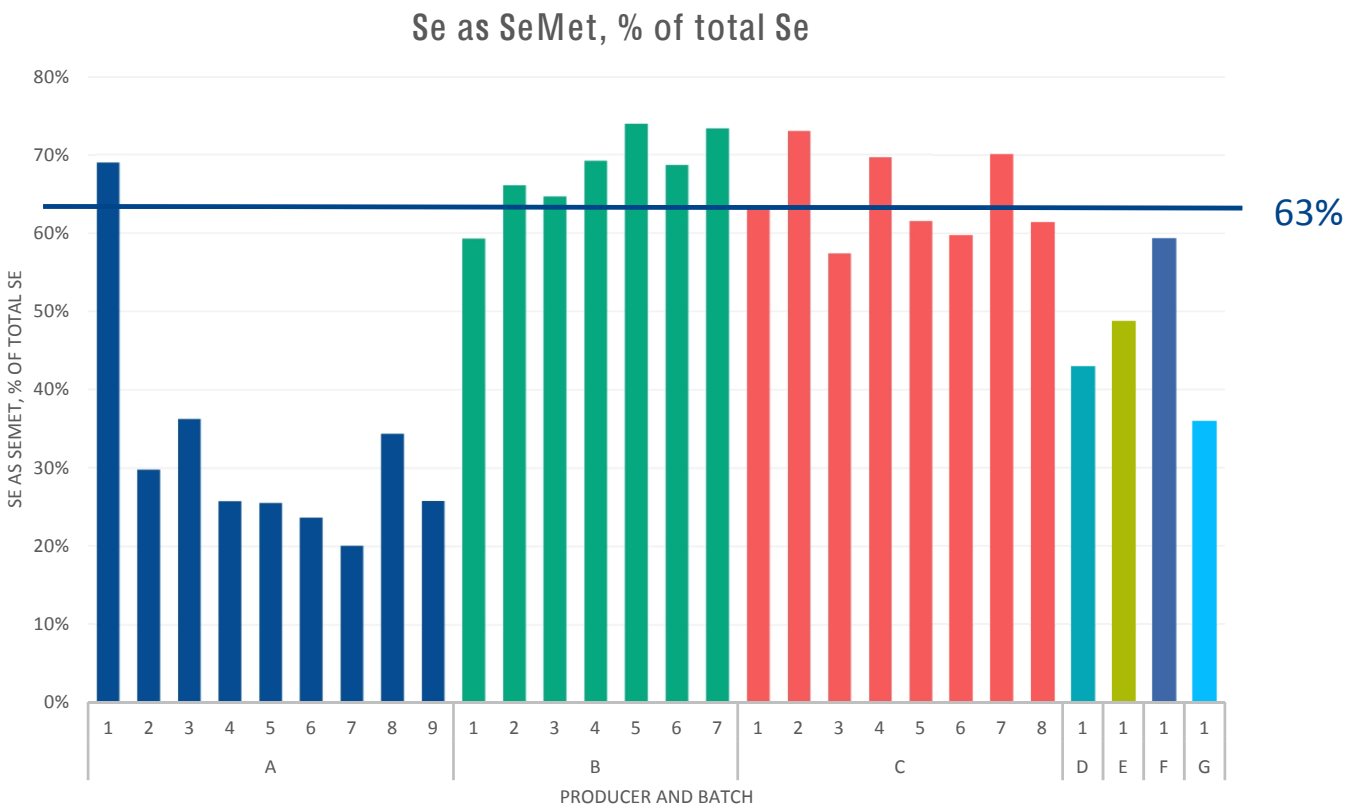
Launch of highly available selenium from organic source (selenized yeast)

(Lyons ea (2007)-Selenium in food chain and animal nutrition- review)

Awareness that Selenomethionine is the active ingredients of main interest and introduction of L-Selenomethionine as such

(Delezie ea (2014)- Comparing responses to different selenium sources and dosages in laying hens)

Selenized Yeast | Commercial sample review 2015

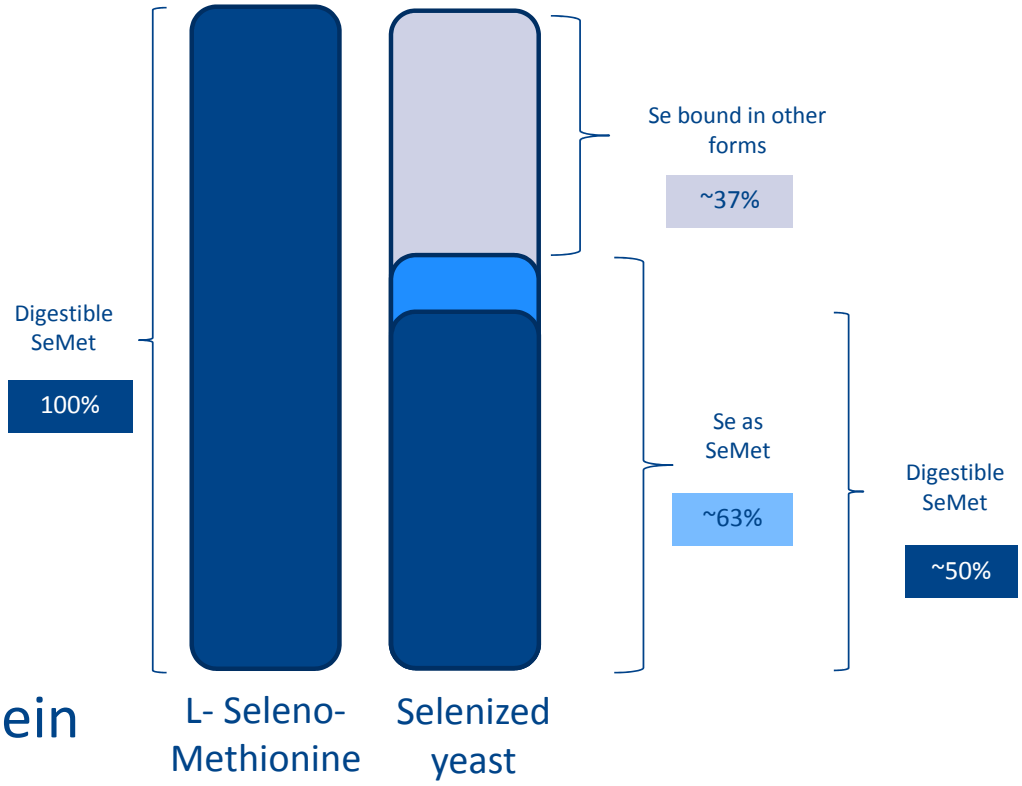


Similar spread has been reported in a large variety of peer reviewed publications:

Schrauzer ea (2006); Zhan ea (2011); Wrobel ea (2003); McSheehy ea (2005); Yoshida ea (2002); Yang ea (2004); Ip ea (2001); Larsen ea (2004); Wolf ea (2001); Polotajko ea (2005)

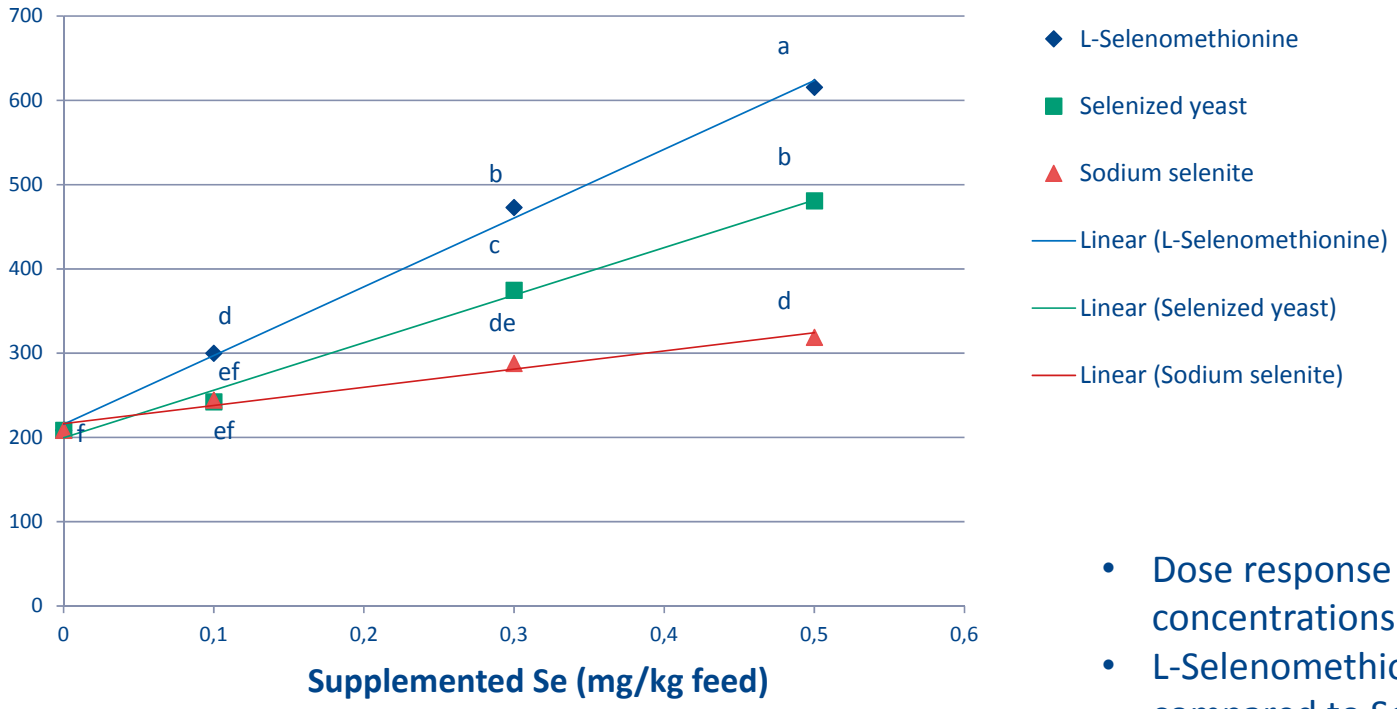
L-Selenomethionine

- New source of organic selenium
- EU registration
  - EU regulation No 121/2014
  - Category 3b (compound of trace element)
  - Nutritional additive for use in all animal species
- Close to 100% available as L-Selenomethionine
- No variation in Selenomethionine level
- Selenomethionine is not bounded in protein structure allowing higher digestibility



Trial results laying hens

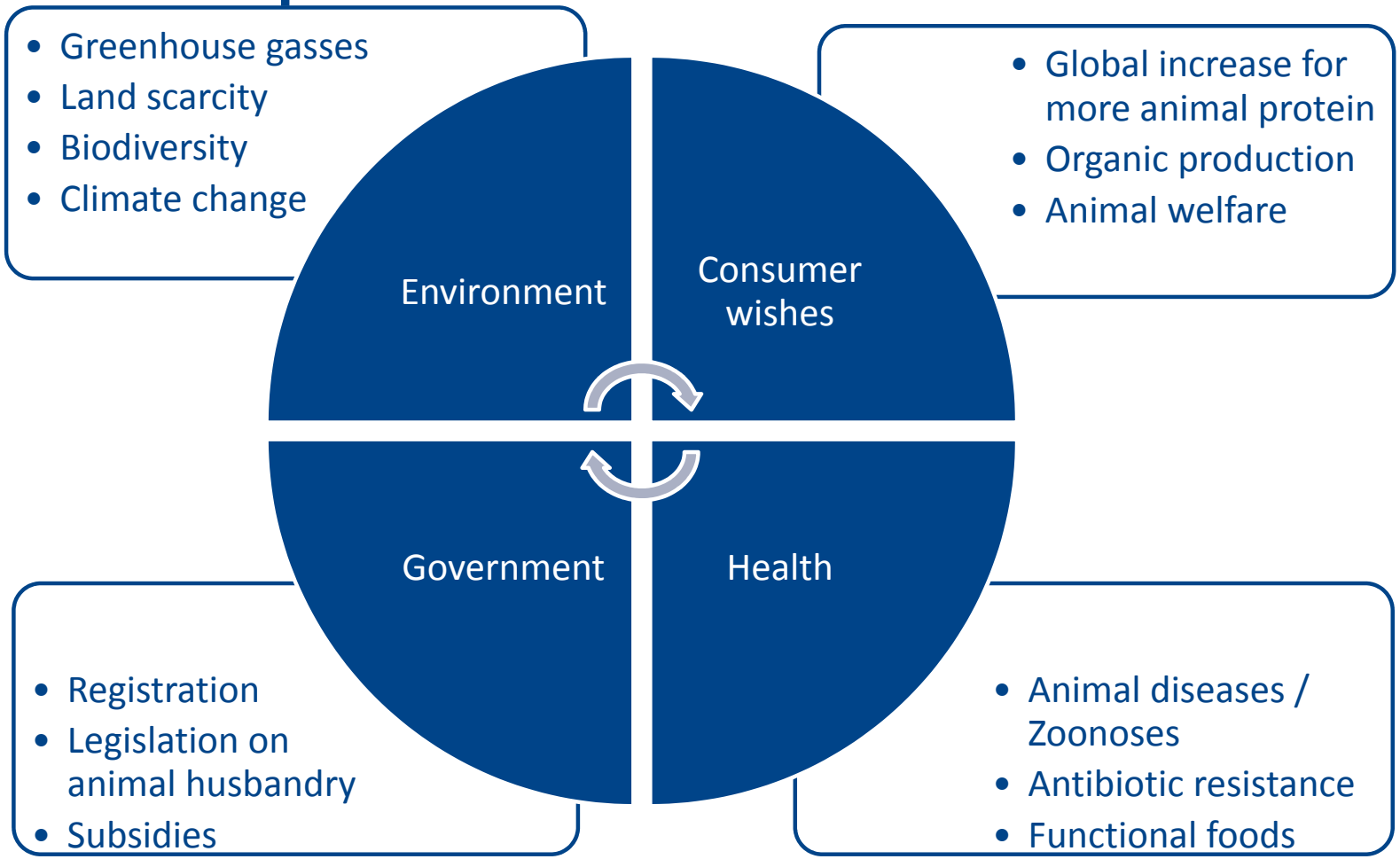
Selenium in eggs (µg/kg), d56



- Dose response effect of the different Se sources on Se concentrations in eggs
- L-Selenomethionine has significant higher transfer compared to SeYeast

Delezie et al (2014); Comparing responses to different selenium sources and dosages in laying hens

Issues in animal production



Thank you for your attention

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